Course Description/ Faculty of Science

Department of: Physics

1. Instructor/ Coordinator Oct 9, 2022

Name:	**Prof. Ahmed Al-Jamel**
Office Hours:	Sun &Tue (10:00-11:00); other times by appointment.
Office No. and Phone:	Al-Baironi 2nd Floor X3571
Email:	aaljamel@aabu.edu.jo
Teaching Assistant (if any):	NA

2. Course Information

Level: B.Sc. (4th year)	Course Title: **Elementary Particle Physics**	Course No.: 402465
Class Time: Sun, Tue, Thu 13:30-14:30	Prerequisite / Co-requisite: quantum mechanics	Course Type: Theoretical
Study Hours:	Semester: Fall	Academic Year: 2022-2023
Type of teaching: ⊡ **Face to face** ☑ **Blended (**☑2:1 ⊡1:1 ⊡1:2) ⊡ **Online**		

3. Textbook(s)

Title	Introduction to Elementary Particles
Author	**David J. Griffiths**
Publisher	Harper & Row Publisher
Year	2004
Edition	3rd ed. Edition or later if available
Textbook Website	-----

4. References (books and research published in periodicals or websites)

1-	Donald H. Perkins, Introduction to High Energy Physics, Addison-Wesley Publishing Company, Inc. 5th Ed. (2000).
2-	B.R. Martin & G. Shaw, Particle Physics, John Wiley & Sons, (1997).
3-	The Review of Particle Physics: http://pdg.lbl.gov

5. Course Description

This course is an introduction to particle physics for seniors (4^{th} year level). The main topics to be covered are: Basic Concepts such as natural units, relativistic kinematics, the Standard Model (quarks, leptons, and gauge bosons), fundamental interactions (EM, Strong, Weak) and their main characteristics, groups and symmetry principle, conservation laws (parity, charge conjugate, time-reversal, CPT, isospin, hypercharge, etc.), experimental methods (detectors, accelerators, and cosmic rays).

6. Course Outcomes (CO's)

Upon successful completion of the course, student will be able to:

CO#		SO
CO1	**Recognize** the basic terminologies and experimental tools related to particle physics.	1
CO2	**Classify** elementary particles and their interactions in terms of quantum numbers according to the Standard Model.	1
CO3	**Use** symmetry principles and conservation laws on various interactions, draw their Feynman diagrams, and verify whether they are allowed or forbidden.	1
CO4	**Calculate** the outcome of various reactions and decay processes using relativistic kinematics (4-vector momentum notation) and invariant mass concept.	3
CO5	**Apply** the Schrödinger equation as an energy eigenvalue problem on bound states (mesons and baryons) with confining potential.	3
CO6	**Apply** the Feynman calculus and Fermi Golden rules to evaluate the cross section and decay rates for some interactions.	3

7. Course Contents (Tentative)

Week #	Topic	Chapter
1	**Chapter 1: Introduction**	1
2+3	**Chapter 2: Elementary Particle Dynamics** Particle exchange, Yukawa theory, EM, strong, weak, and gravitational interactions, Feynman diagrams. Decays and conservation laws	2
4+5	**Chapter 3: Relativistic Kinematics** Lorentz transformation, Four-vectors, Energy and momentum, Relativistic collisions.	3
6+7+8	**Chapter 4: Symmetries and Conservation Laws** Symmetries, Groups and conservation laws, PT and CPT symmetries, internal symmetries, conservation laws, quantum numbers.	4
9+10+11	**Chapter 5: Bound States** The Schrodinger equation, Heavy quarkonia (Charmonium and bottomonium), light quarks mesons, baryons.	5
12+13+14	**Chapter 6: The Feynman Calculus** Cross section and decay rates review; Fermi Golden rules; The Feynman rules firstly using the ABC-Toy model and then the real rules. Examples	6
15+16	**Chapter * Miscellaneous topics** The color charge, color algebra, evidence of color existence. QED and QCD and Gauge theories; Experimental Methods: Accelerators (linear and cyclic), focusing and beam stability, fixed-target experiments, colliding-beam machines, detectors.	**Misc.**
AS TIME PERMITS	**Review and closing remarks**	----

8. Teaching and learning Strategies and Evaluation Methods

	Evaluation /Measurement Method (Exam/ presentations/ discussion/ assignments	Learning Activities	Teaching Strategies	Learning Outcomes
1.	Homework, Assignments, Exams	Practice problem-based learning	Lecturing; Direct instructions; Interactive Instruction	**CO1**
2.	Homework, Assignments, Exams	Practice problem-based learning,	Lecturing; Direct instructions; Interactive Instruction	**CO2**
3.	Homework, Assignments, Exams	Practice, problem-based learning,	Lecturing; Direct instructions; Interactive Instruction	**CO3**
4.	Homework, Assignments, Exams	Practice, problem-based learning,	Lecturing; Direct instructions; Interactive Instruction;	**CO4**
5.	Homework, Assignments, Exams	Practice, problem-based learning,	Lecturing; Direct instructions; Interactive Instruction	**CO5**
6.	Homework, Assignments, Exams	Practice problem-based learning,	Lecturing; Direct instructions; Interactive Instruction	**CO6**

9. Assessment

Distribution of grades	Assessment Time	Methods Used
30%	Per week	HW, Assignments, Project **No late homework is accepted**.
30%	TBA	Midterm Exam
40%	TBA	Final Exam

10. Program Educational Objectives (PEOs)

PEO1	Demonstrate a solid scientific and technical competence using what they learned in physics and related fields to excel in their careers.
PEO2	Exhibit the ability to engage in life-long learning, training, and self-development, assimilating the changes and advances in the profession and pursuing graduate studies.
PEO3	Exhibit professional integrity, productive teamwork, effective communication skills, and the capability for ethical decision making.

11. Student Learning Outcomes for the Program. (SO's)

SO's (1-6)	Science Student Learning Outcomes for the Program
1	An ability to identify, formulate, and solve broadly defined technical or scientific problems by applying knowledge of mathematics and science and/or technical topics to areas relevant to the discipline.
2	An ability to formulate or design a system, process, procedure or program to meet desired needs.
3	An ability to develop and conduct experiments or test hypotheses, analyze and interpret data and use scientific judgment to draw conclusions.
4	An ability to communicate effectively with a range of audiences.
5	An ability to understand ethical and professional responsibilities and the impact of technical and/or scientific solutions in global, economic, environmental, and societal
6	An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

12. Mapping between Student Outcomes and Program Educational Objectives

	SO1	SO2	SO3	SO4	SO5	SO6
PEO1	■	■	■			
PEO2			■	■	■	
PEO3					■	■